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N79-31178

FIREMEN PROGRAM STATUS REPORT

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Boeing Commercial Airplane Company
March 1979**

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DEVELOPMENT AND FABRICATION PROGRAMS

DEVELOPMENT PROGRAM

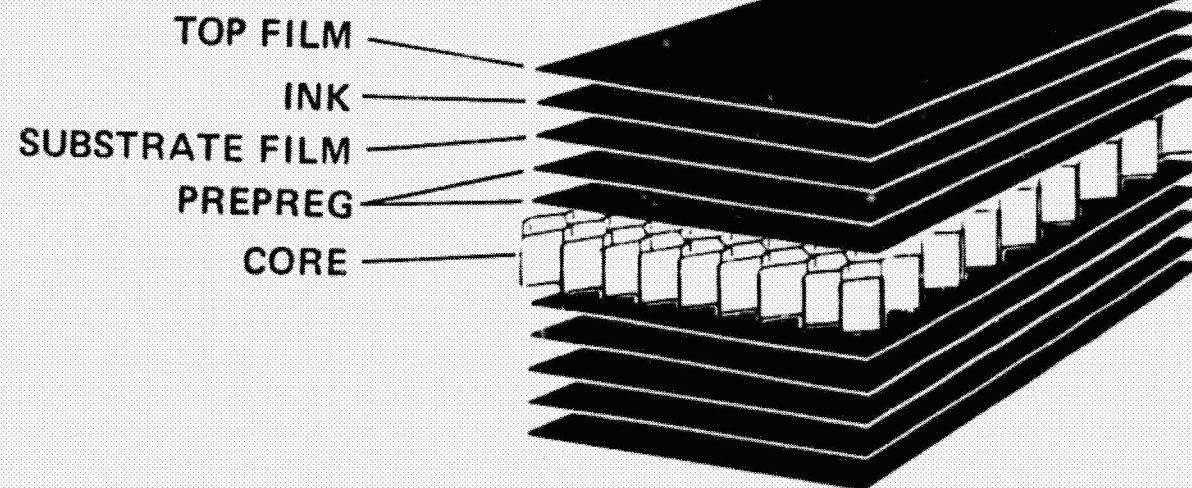
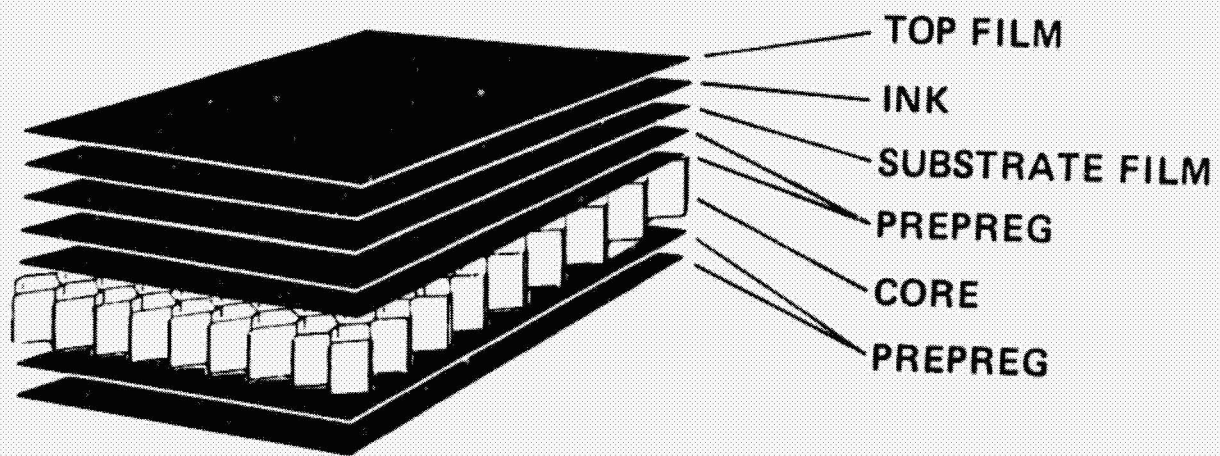
OVERVIEW

- **BEGAN IN 1975**
- **FOUR PHASE PARTICIPATION**
- **INTERIOR SANDWICH PANEL DEVELOPMENT**

OBJECTIVES

- **IMPROVE**
 - **FLAMMABILITY**
 - **SMOKE EMISSION**
 - **TOXICITY**
- **MAINTAIN**
 - **MECHANICAL PROPERTIES**
 - **AESTHETICS**
 - **SERVICEABILITY**
 - **COSTS**

SANDWICH PANEL MAKEUP



- **PHASE I – BASELINE LAVATORY BURN
(NAS2 – 8700)**
- **PHASE II – RESIN SYSTEM DEVELOPMENT
(NAS2 – 8700)**
- **PHASE III – DECORATIVE FILM DEVELOPMENT
(NAS2 – 8700)**
- **PHASE IV – DECORATIVE INK DEVELOPMENT
(NAS2 – 9864)**

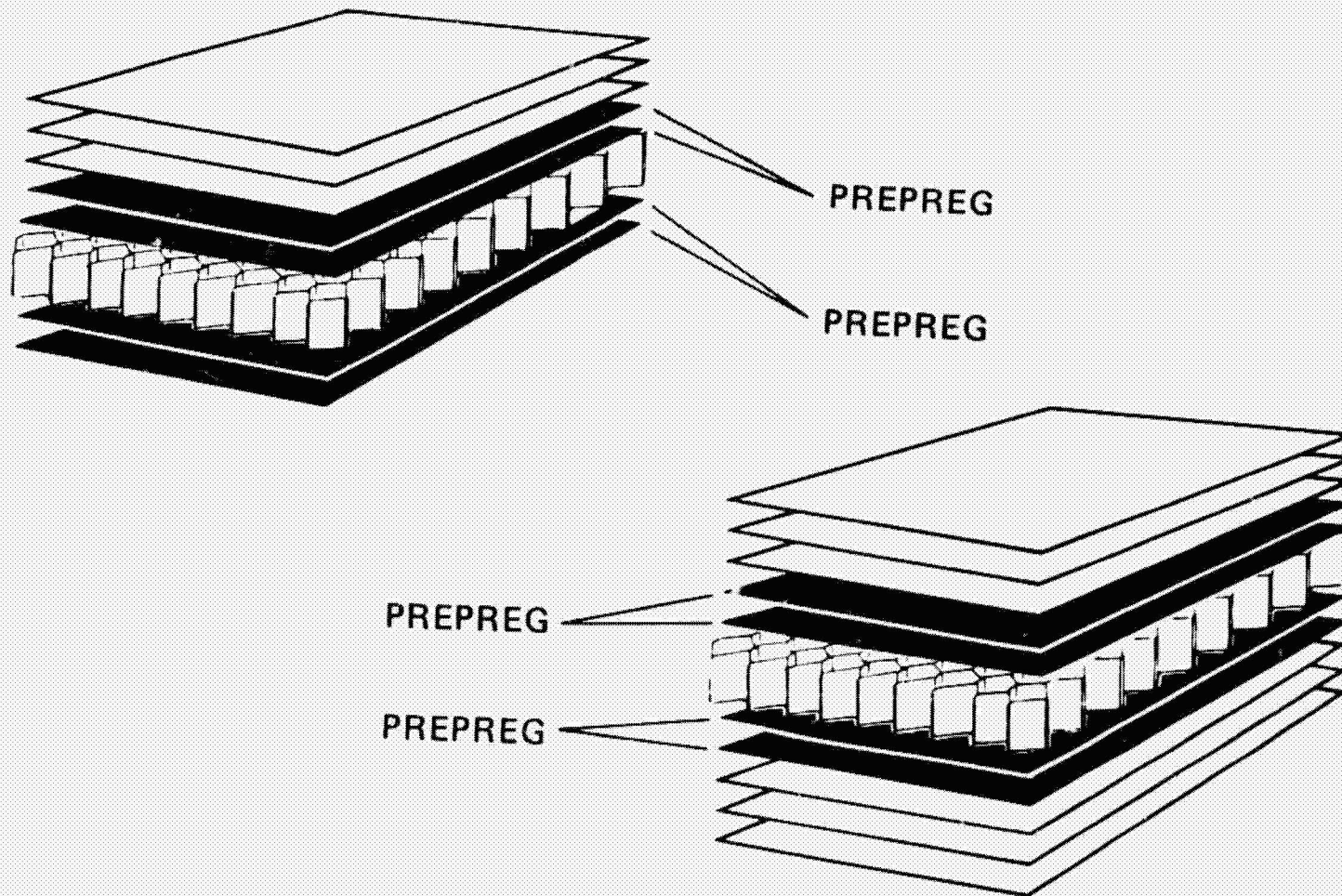
PHASE I – BASELINE LAVATORY BURN

- **747 LAVATORY MODULE**
- **TEST CONDITIONS**
 - **30 MINUTES**
 - **DOOR CLOSED**
 - **10 POUNDS TRASH**
- **INFLIGHT, UNOBSERVED FIRE**

RESULTS

- **FIRE CONTAINED**
- **CURRENT CONSTRUCTION ADEQUATE**
- **NASA CR-152074**

PHASE II – RESIN SYSTEM DEVELOPMENT



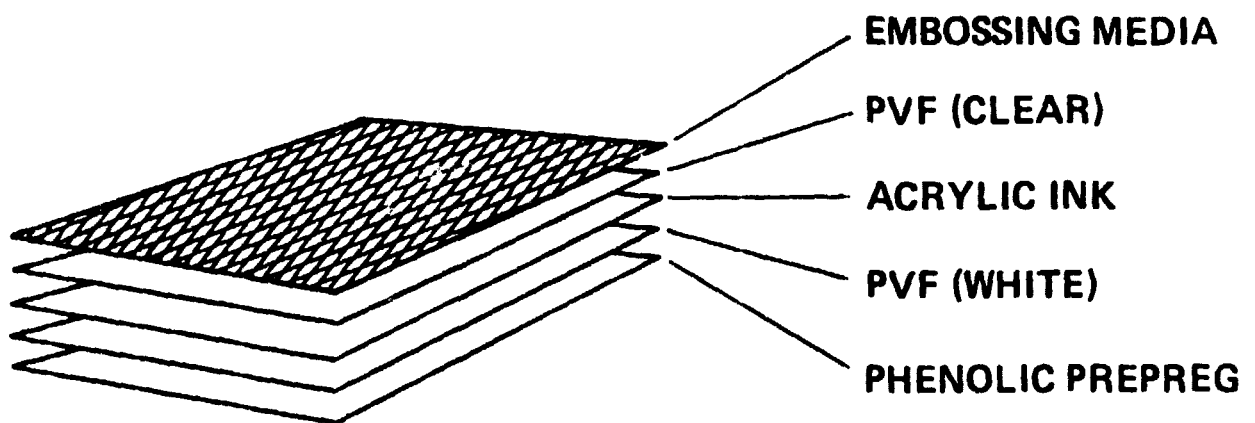
APPROACH

- **CANDIDATE RESIN SYSTEMS**
 - **BASELINE EPOXY**
 - **BISMALEIMIDE**
 - **PHENOLIC**
 - **POLYIMIDE**
- **TESTING MATRIX**
 - **FLAMMABILITY, SMOKE, AND TOXICITY**
 - **MECHANICALS AND AESTHETICS**

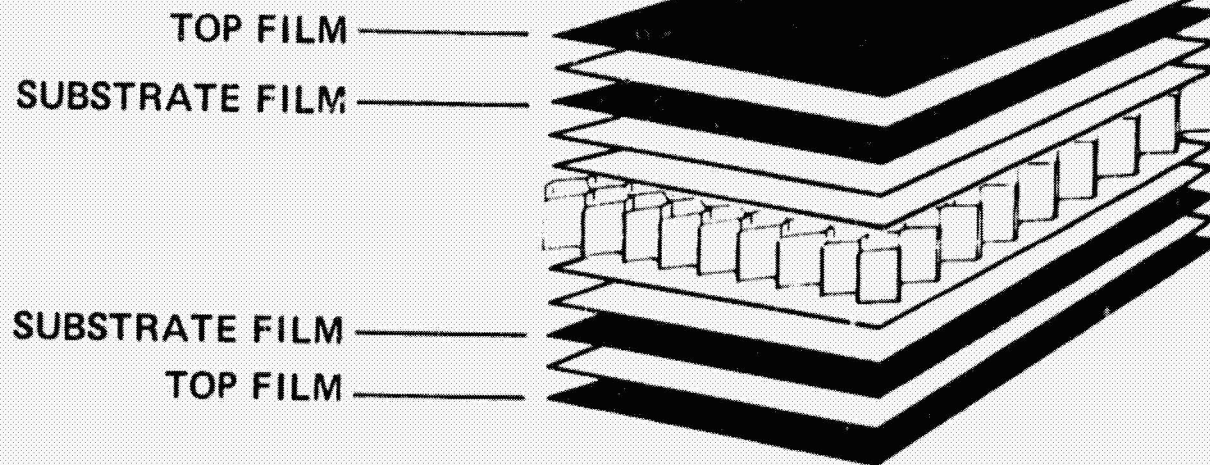
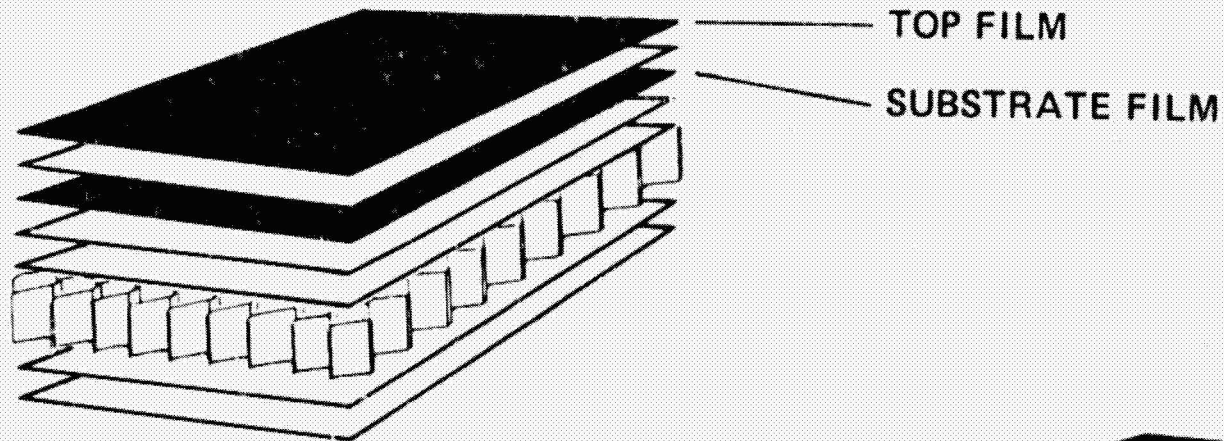
RESULTS

- **PHENOLICS**
 - **FLAMMABILITY, SMOKE, AND TOXICITY**
 - **MATERIAL AND FABRICATION COSTS**
 - **LABORATORY SCALE TESTING**
- **PROBLEM**
 - **AESTHETICS**
- **NASA CR-152120**

DECORATIVE LAMINATE MAKEUP



PHASE III – DECORATIVE FILM DEVELOPMENT



OVERVIEW

- **NUMEROUS CANDIDATES**
- **TESTING MATRIX**
 - **FLAMMABILITY, SMOKE, AND TOXICITY**
 - **MECHANICALS AND AESTHETICS**

APPROACH

- **SINGLE FILM**
- **SOFT DECORATIVE LAMINATE**
- **HARD DECORATIVE LAMINATE**
- **SANDWICH PANEL**

SINGLE FILM EVALUATION

- **LOI**
- **D_S AT 1.5 AND 4 MINUTES**
- **D_M**
- **CO, HF, AND HCL AT 4 MINUTES**
- **18 CANDIDATES**

EVALUATION FORMULAS

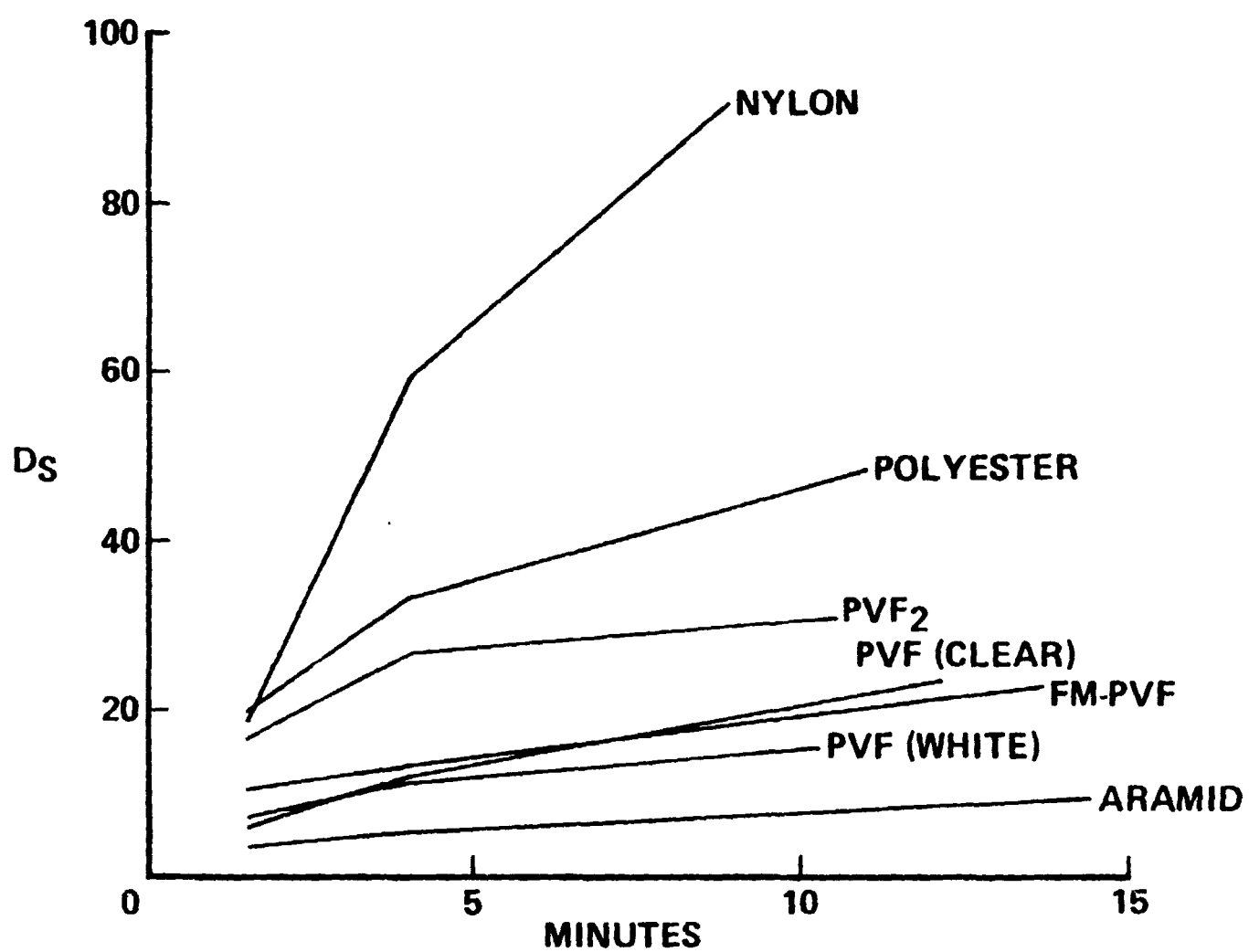
$$A = \left(\frac{LOI}{300} \right) + \left(\frac{50 - D_S(1.5)}{450} + \frac{100 - D_S(4.0)}{900} + \frac{200 - D_M}{1800} \right) + \left(\frac{100 - CO}{900} + \frac{10 - HCL}{90} + \frac{100 - HF}{900} \right)$$

$$B = \left(\frac{LOI}{100} \right)^{1/3} \times \left[\left(\frac{50 - D_S(1.5)}{50} \right) \left(\frac{100 - D_S(4.0)}{100} \right) \left(\frac{200 - D_M}{200} \right) \right]^{1/9} \times \left[\left(\frac{100 - CO}{100} \right) \left(\frac{10 - HCL}{10} \right) \left(\frac{100 - HF}{100} \right) \right]^{1/9}$$

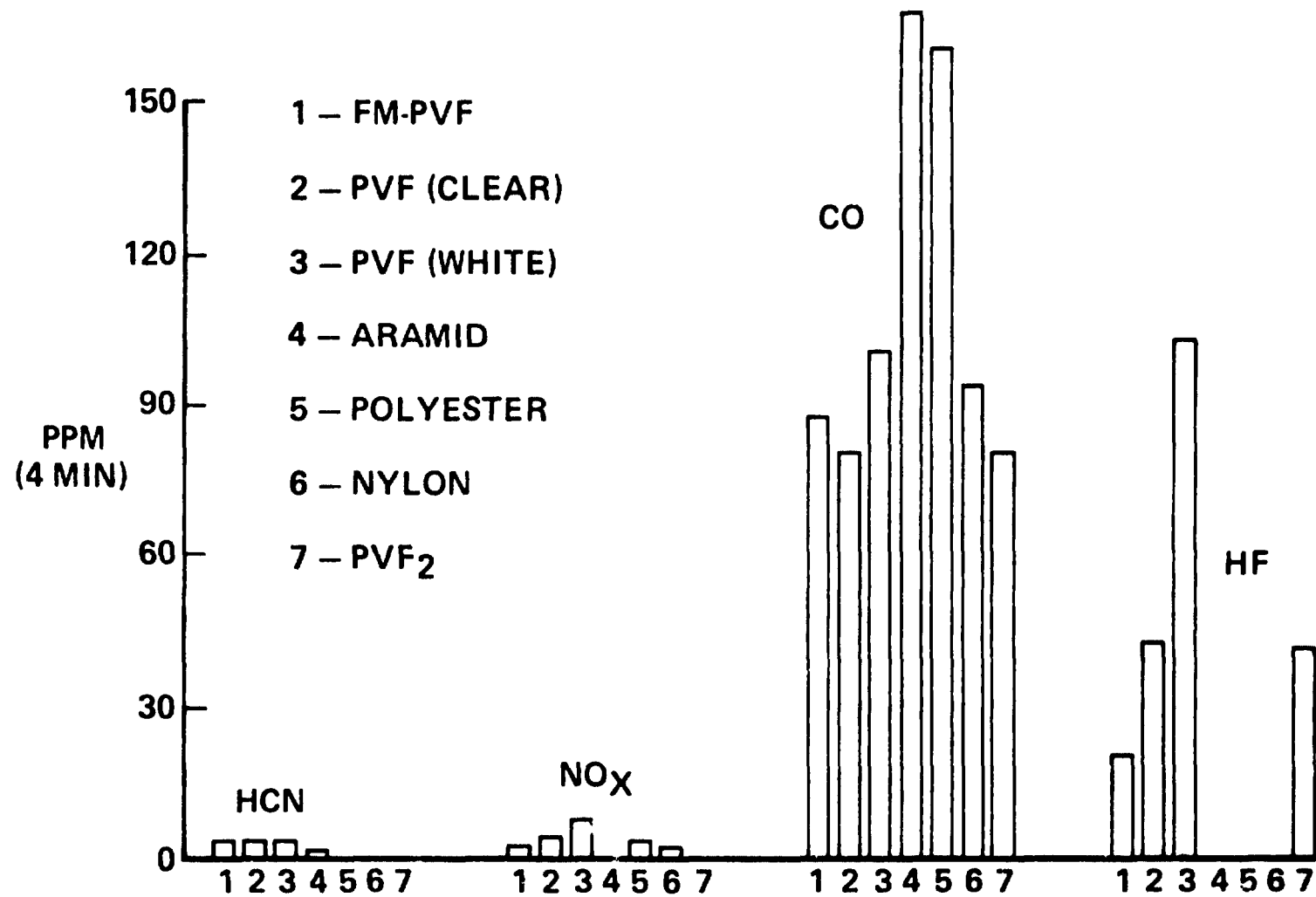
FURTHER EVALUATION

- **PRINTABILITY**
- **EMBOSSABILITY**
- **UV STABILITY**
- **HEAT RELEASE**
- **SMOKE EMISSION**
- **TOXIC GAS EMISSION**
- **FLAME SPREAD INDEX**
- **5 CANDIDATES**

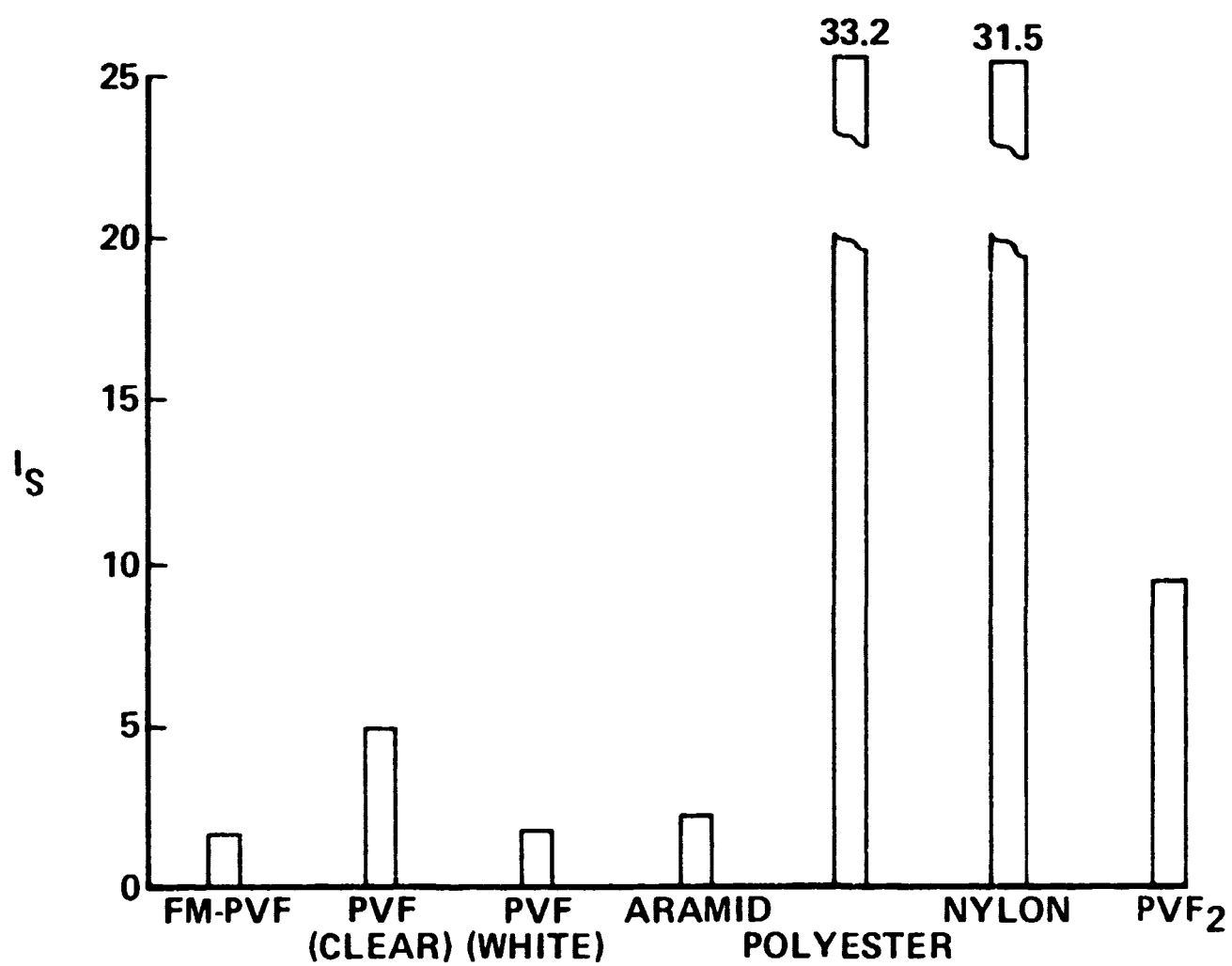
SMOKE EMISSION



TOXIC GAS EMISSION



FLAME SPREAD INDEX



EVALUATION FORMULAS

$$A = \left(\frac{35 - I_S}{105} \right) + \left(\frac{50 - D_S(1.5)}{450} + \frac{100 - D_S(4.0)}{900} + \frac{100 - D_M}{900} \right) \\ + \left(\frac{200 - CO}{2400} + \frac{10 - HCN}{120} + \frac{10 - NO_X}{120} + \frac{150 - HF}{1800} \right)$$

$$B = \left(\frac{35 - I_S}{35} \right)^{1/3} \times \left[\left(\frac{50 - D_S(1.5)}{50} \right) \left(\frac{100 - D_S(4.0)}{100} \right) \left(\frac{100 - D_M}{100} \right) \right]^{1/9} \\ \times \left[\left(\frac{200 - CO}{200} \right) \left(\frac{10 - HCN}{10} \right) \left(\frac{10 - NO_X}{10} \right) \left(\frac{150 - HF}{150} \right) \right]^{1/12}$$

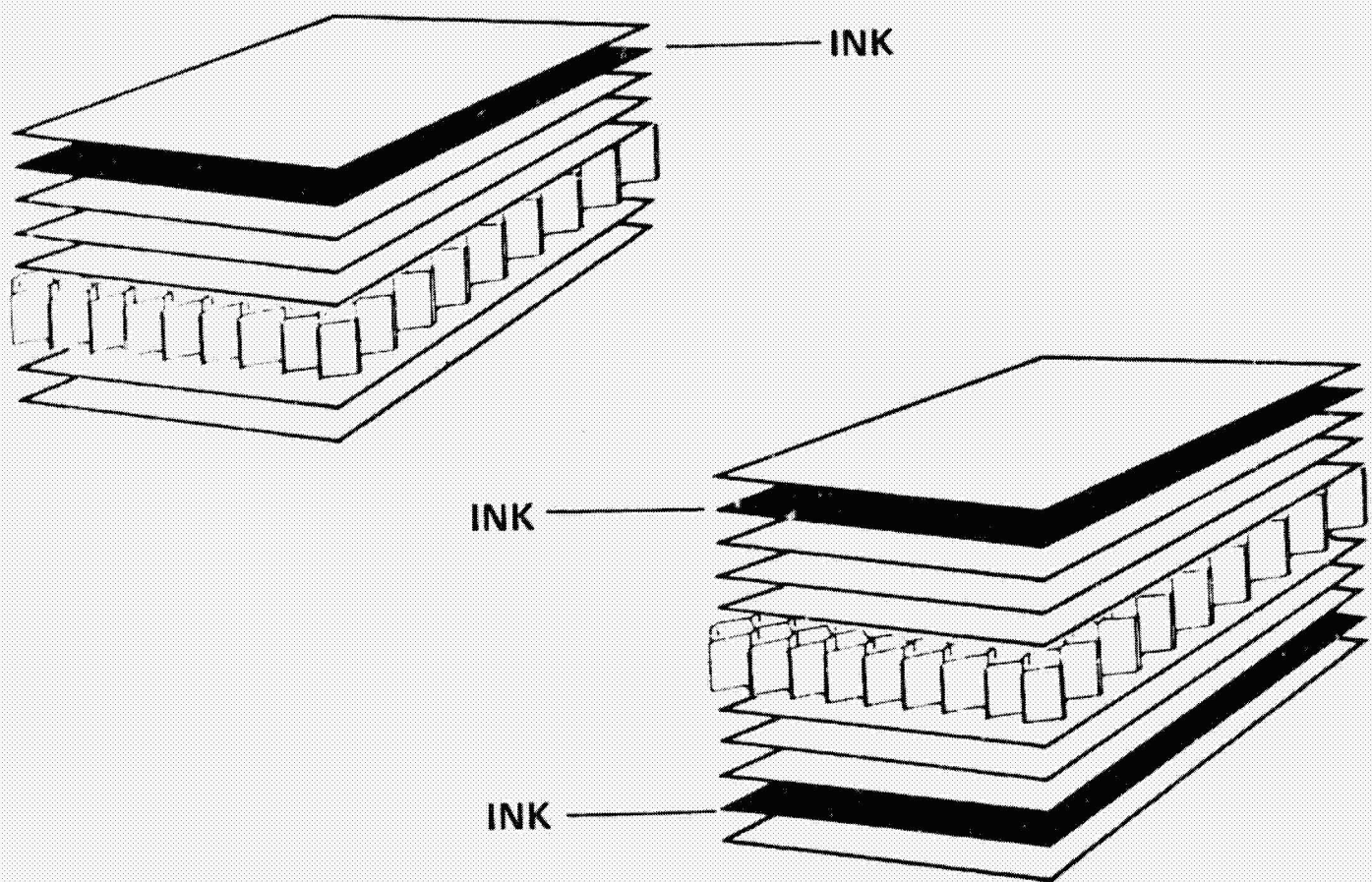
CURRENT CANDIDATES

- **TOP FILM**
 - **PVF (CLEAR)**
- **SUBSTRATE FILMS**
 - **ARAMID**
 - **FM-PVF**
 - **PVF (WHITE)**
 - **PVF₂**
 - **DUPONT EXPERIMENTAL**
 - **FPE-P**

FUTURE WORK

- **SOFT DECORATIVE LAMINATES**
 - **SMOKE AND TOXIC GAS EMISSION**
 - **60 SEC VERTICAL FLAMMABILITY**
 - **PEEL STRENGTH**
- **HARD DECORATIVE LAMINATES**
 - **PEEL STRENGTH**
 - **AESTHETICS**
 - **ABRASION RESISTANCE**

PHASE IV – DECORATIVE INK DEVELOPMENT



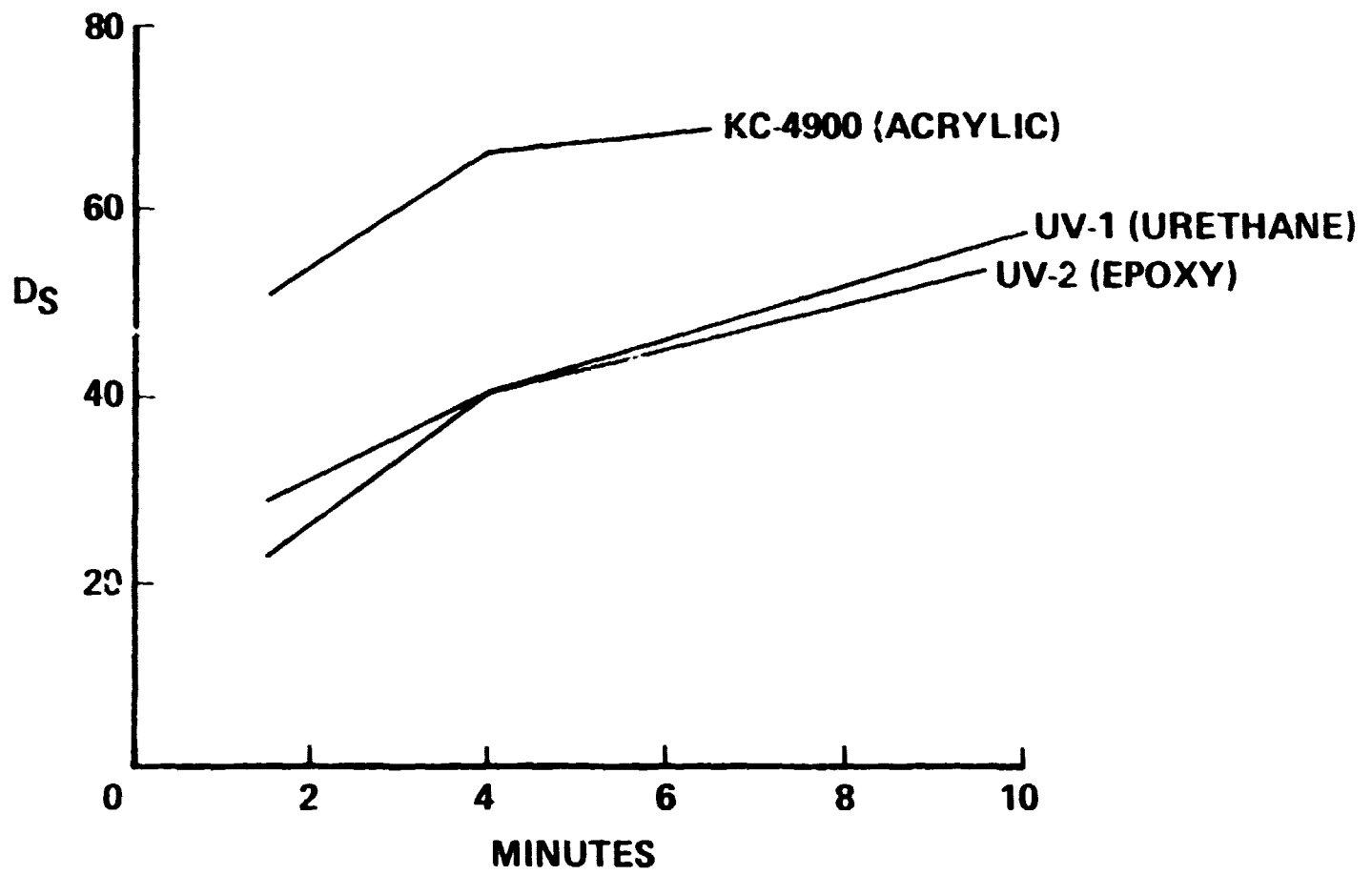
MATERIAL REQUIREMENTS

- **5 MIL FILM**
- **LOI ≥ 35**
- **$D_S \leq 20$ (2.5 W/CM², 4 MINUTES)**
- **TGA (N₂ AND AIR) RT \rightarrow 250° C**
- **LC₅₀ \geq 70 MG/L**

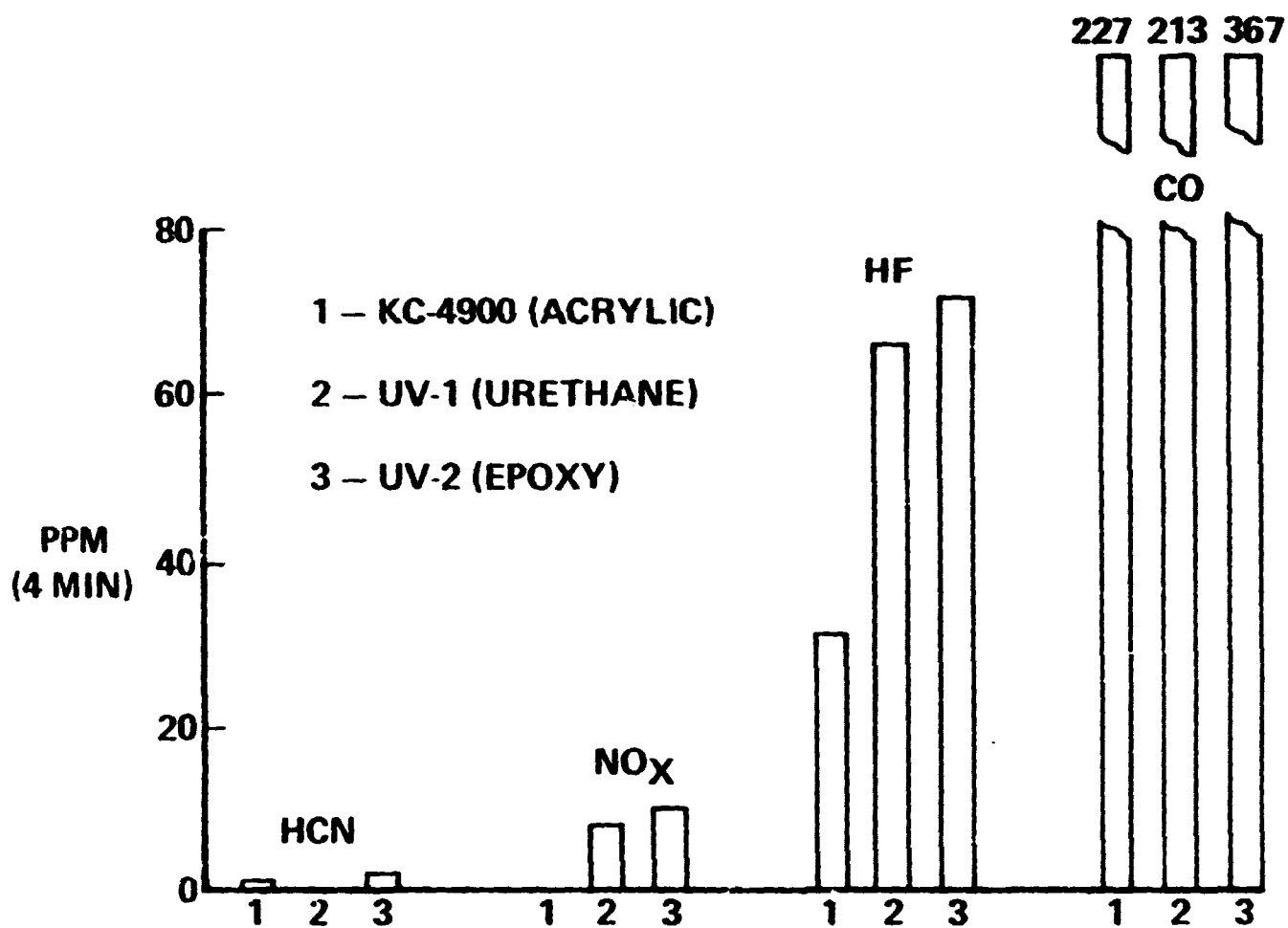
APPROACH

- **UV CURED INKS**
 - **VISCOSITY VARIATION**
 - **AIR QUALITY REGULATIONS**
 - **TECHNOLOGY AVAILABLE**
- **SUBCONTRACT**
 - **K.C. COATINGS, INC.**
 - **6-MONTH EFFORT**
 - **NEGOTIATIONS IN PROGRESS**

SMOKE EMISSION



TOXIC GAS EMISSION



FABRICATION PROGRAMS

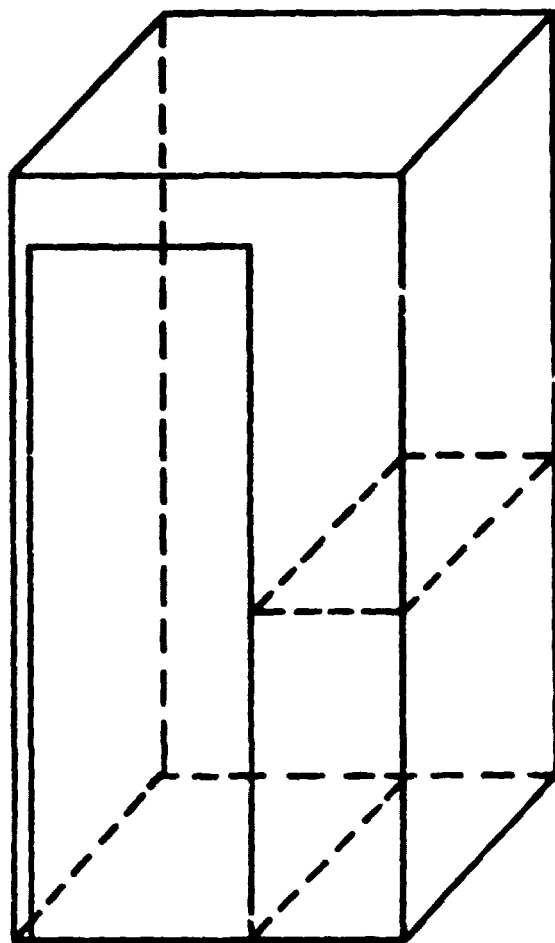
OVERVIEW

- **BEGAN IN DECEMBER, 1977**
- **INTERIOR SANDWICH PANELS**
- **LAVATORY PANEL FABRICATION
(NAS9 – 13000)**
- **INTERIOR PANEL FABRICATION
(NAS2 – 10004)**

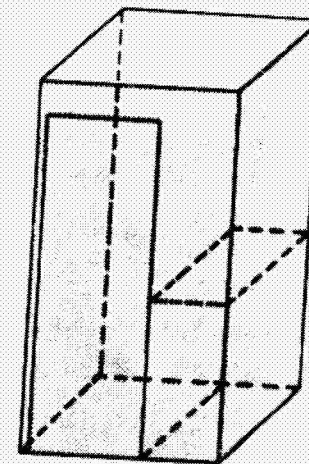
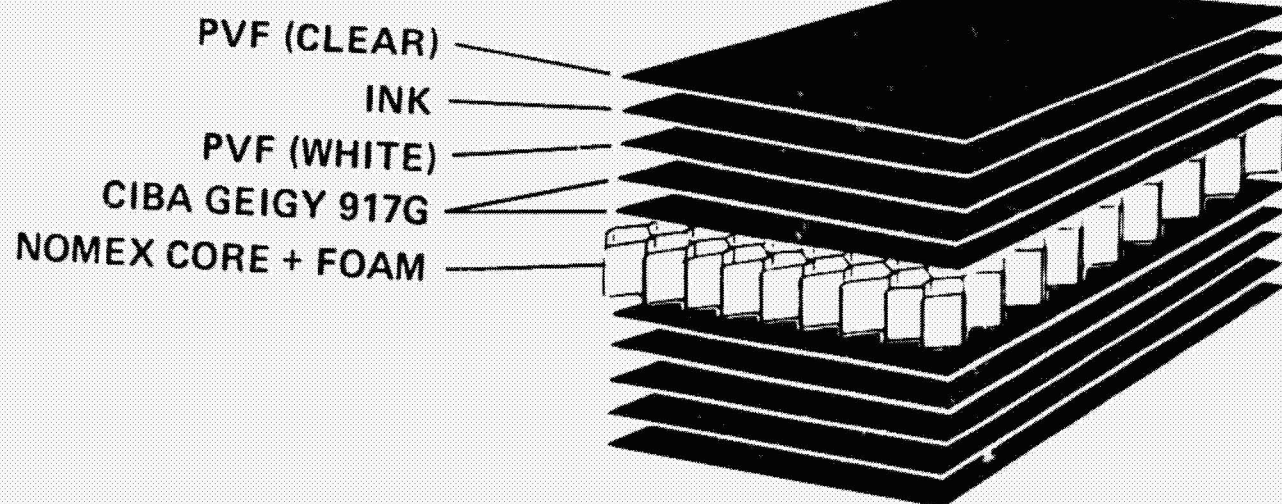
LAVATORY PANEL FABRICATION

- **NASA-JSC**
- **9 PANELS**
- **DC-10 LAVATORY SIMULATION**

LAVATORY SCHEMATIC

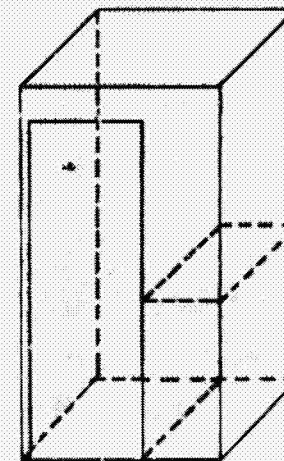
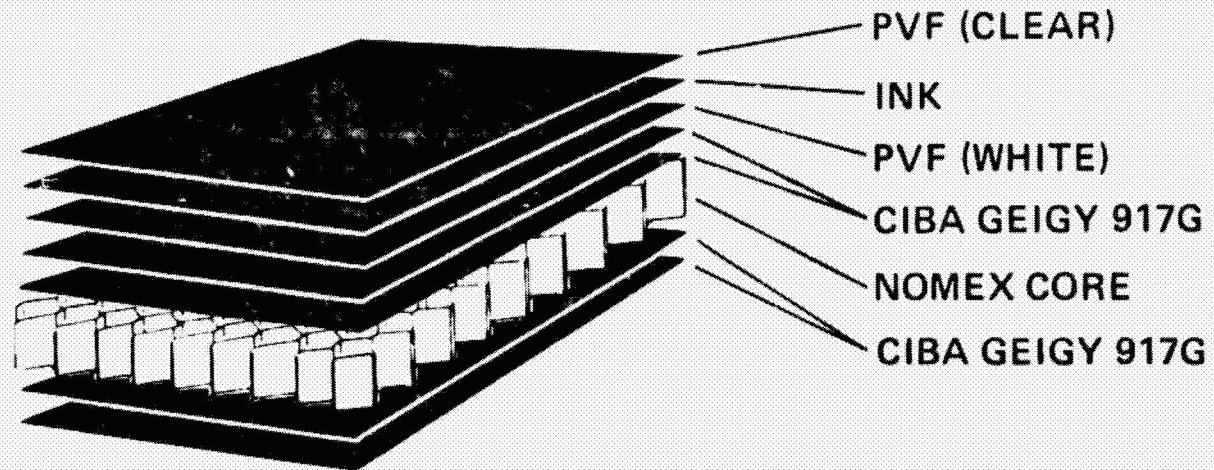


DOUBLE DECORATED PANEL



SINGLE DECORATED PANEL

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OF POOR QUALITY



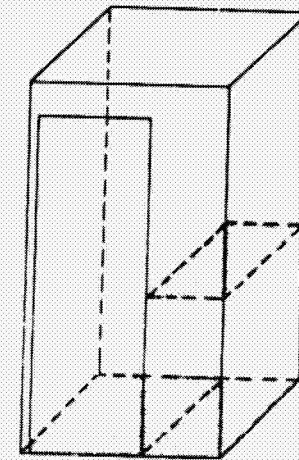
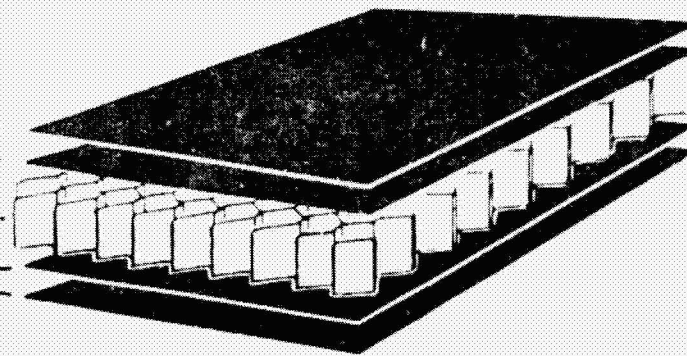
UNDECORATED PANEL

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QUALITY

CIBA GEIGY 917G

NOMEX CORE

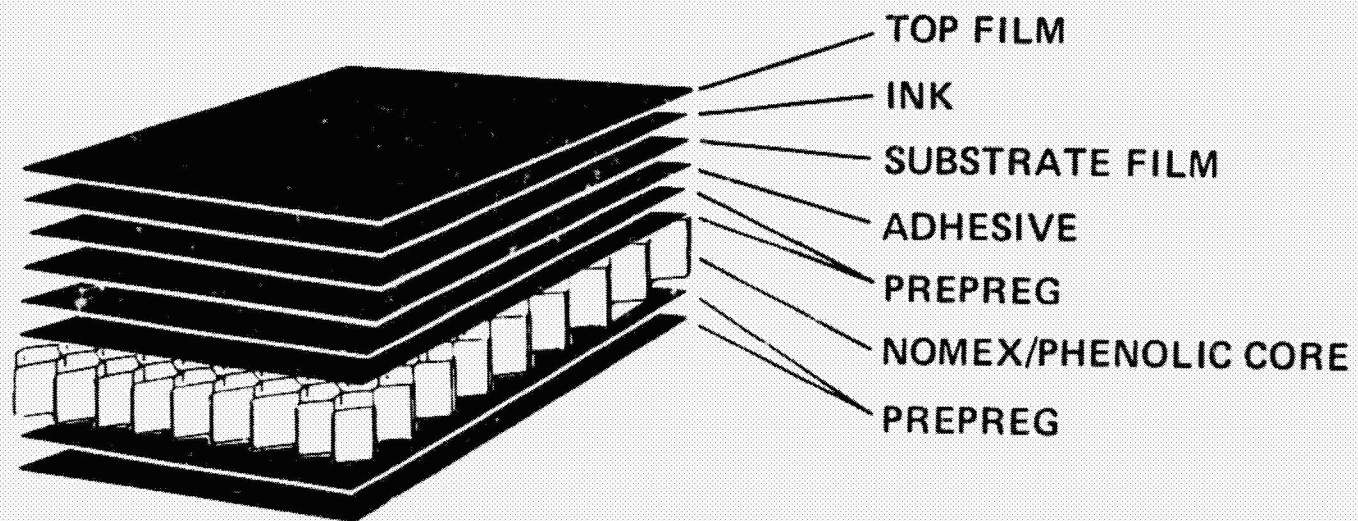
CIBA GEIGY 917G



INTERIOR PANEL FABRICATION

- **NASA-ARC**
- **56 PANELS**
- **40 X 96 X 1 INCH**
- **FAA-NAFEC**
- **VARIOUS THERMOPLASTIC FILMS**

PANEL MAKEUP



PANEL MATERIALS

DECORATIVE FILM			ADHESIVE	PREPREG	
TOP	INK	SUBSTRATE		181	120
1 MIL PVF	ACRYLIC	2 MIL PVF	—	EPOXY	EPOXY
1 MIL PVF +3 MIL PVC	ACRYLIC	2 MIL PVF	TF-252	EPOXY	EPOXY
—	—	3 MIL PC	TF-252	PHENOLIC	PHENOLIC
1 MIL PVF	—	2 MIL PVF	TF-252	PHENOLIC	PHENOLIC
1 MIL PVF	—	5 MIL PC	TF-252	PHENOLIC	PHENOLIC
—	—	3 MIL PVF ₂	TF-252	PHENOLIC	PHENOLIC
—	—	3 MIL PES	TF-252	PHENOLIC	PHENOLIC
1 MIL PVF	ACRYLIC	2 MIL PVF	TF-252	PHENOLIC	PHENOLIC